Statistical Estimation of Orbital Debris Populations with a Spectrum of Object Size

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Orbital debris is a real concern for the safe operations of satellites. In general, the hazard of debris impact is a function of the size and spatial distributions of the debris populations. To describe and characterize the debris environment as reliably as possible, the current NASA Orbital Debris Engineering Model (ORDEM2000) is being upgraded to a new version based on new and better-quality data. The data-driven ORDEM model covers a wide range of object sizes from 10 microns to greater than 1 meter. This paper reviews the statistical process for the estimation of the debris populations in the new ORDEM upgrade, and discusses the representation of large-size (≥ 1 m and ≥ 10 cm) populations by SSN catalog objects and the validation of the statistical approach. Also, it presents results for the populations with sizes of ≥ 3.3 cm, ≥ 1 cm, ≥ 100 μm, and ≥ 10 μm.

The orbital debris populations used in the new version of ORDEM are inferred from data based upon appropriate reference (or benchmark) populations instead of the binning of the multi-dimensional orbital-element space. This paper describes all of the major steps used in the population-inference procedure for each size-range. Detailed discussions on data analysis, parameter definition, the correlation between parameters and data, and uncertainty assessment are included.

Paper Outline

1. Introduction
2. Statistical estimation of OD populations
    a. General approach
    b. Self-consistency test
3. Large-size OD populations
    a. Cataloged objects
    b. Haystack/HAX data
    c. RCS and size of OD objects
4. Comparison between cataloged and statistically-estimated populations
    a. Practical examples
    b. Comparison results
5. Estimation of the 3.3-cm population
    a. Haystack and HAX data
    b. Reference population
    c. Statistical inference
6. Estimation of the 1-cm population
    a. NaK module and the estimation of NaK population
    b. LEGEND population and the estimation of 1-cm population of breakup fragments
    c. SRM slag
7. Estimation of micron-sized populations
    a. STS impact data
    b. A degradation/ejecta model
    c. Mark-files
    d. Modeling results
8. Summary and Remarks